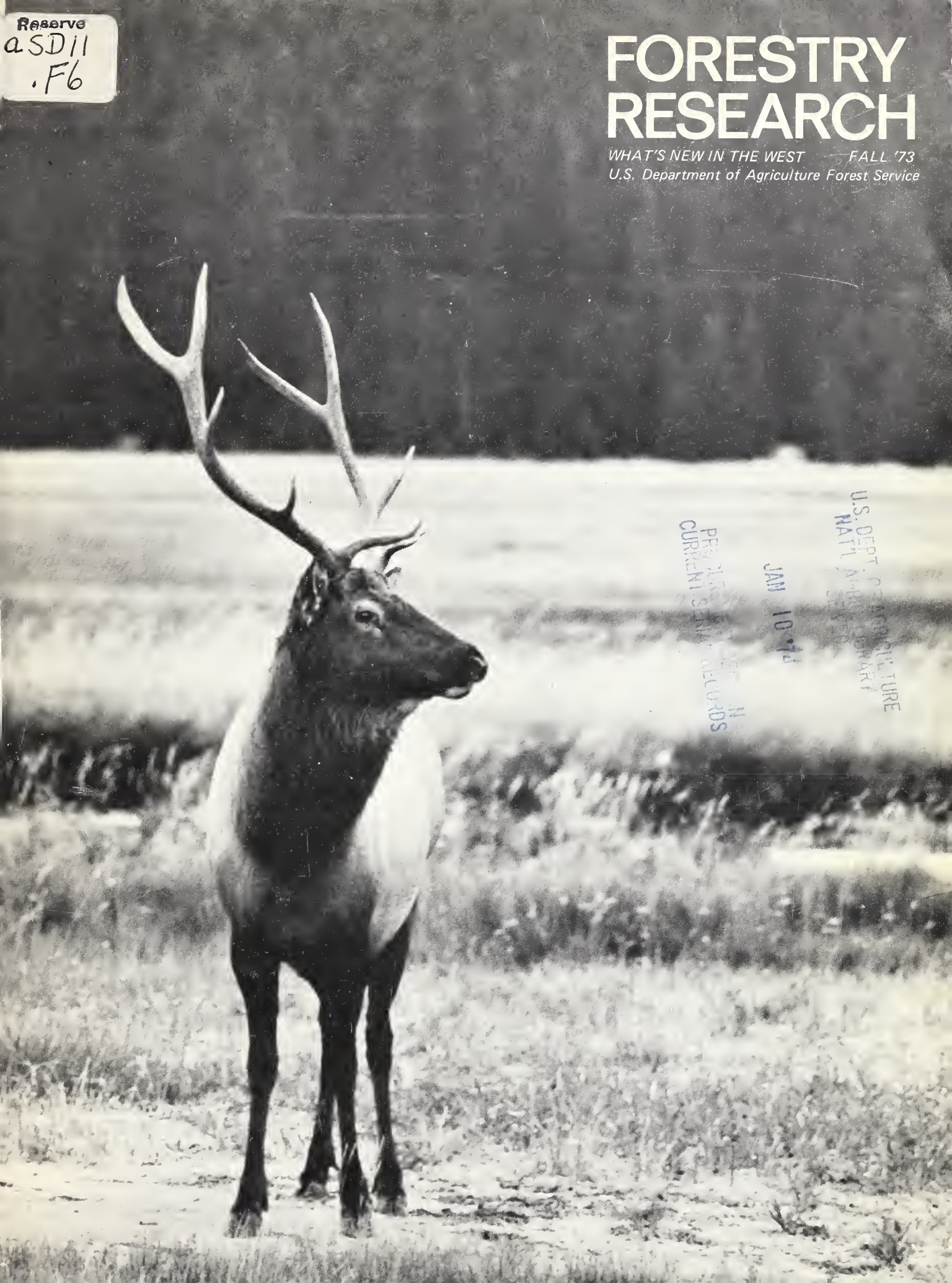
FORESTRY RESEARCH

WHAT'S NEW IN THE WEST *FALL '73*

U.S. Department of Agriculture Forest Service



Wapiti, commonly known as elk, are related to Europe's red deer.

understanding ELK

Elk once roamed plains and foothill regions of the western United States. Apparently, frontier settlements and ranching activity pushed the elk into the mountains. Uncontrolled hunting completely depleted elk populations in some western locales by 1900.

During the early decades of the 20th century, elk were reintroduced on their former ranges. Many of these transplants came from Yellowstone National Park. Several western states now support tens of thousands of these animals. But elk inhabit lands which are sought for recreation, land development, timber harvesting, mining, and many other uses. In addition, other game animals and domestic livestock compete with elk for a share of nature's productivity. How are elk responding to these pressures? What information is needed by land managers to help them plan resource uses compatible with elk needs?

A. Lorin Ward, a research wildlife biologist, is looking for clues that will lead to answers to these questions. He is the leader of a two-man research team from the Rocky Mountain Forest and Range Experiment Station field laboratory at Laramie, Wyoming. The laboratory is located on the University of Wyoming campus, where Ward works cooperatively with University researchers, with Wyoming Game and Fish Commission officers, and with land managers from Wyoming National Forests.

Ward's challenge is to find out how Rocky Mountain elk *(Cervus canadensis nelsoni)* react to various land use pressures, and to determine the key habitat elements that are essential to their existence.

Because available winter range is a factor limiting elk populations, Ward's first effort was to determine which winter range plants are most valuable to feeding elk. From winter feeding sites on the south end of the Medicine Bow Range in south-central Wyoming, he collected samples of grasses, herbs, and shrubs available for elk use during the winter of 1968-69.

In the laboratory, he determined the digestibility of the various species in solutions inoculated with rumen bacteria collected from cattle and elk. Of the plants tested, Ward found big sagebrush *(Artemisia tridentata)* most digestible (about 53 percent of the volume consumed), followed by a mixture of grasses (43 percent). Lowest in digestibility was antelope bitterbrush *(Purshia tridentata)* (26 percent). More information on this work is available in a *Journal of Wildlife Management* article by Ward, "In Vitro Digestibility of Elk Winter Forage in Southern Wyoming." Reprints are available from the Rocky Mountain Station.

Ward then investigated the effect of sagebrush control on elk calving behavior. Calving activities and feeding habits on an elk calving ground in the Bighorn National Forest were observed for two years prior to sagebrush control with herbicides. The applied herbicides killed 97 percent of the brush on the two areas studied. Surrounding sagebrush and wooded lands were untreated.

Observations made after sagebrush was killed revealed almost no changes in calving and grazing activities. The sprayed area was used just as much after spraying as before. Grasses and forbs were the major items in the spring diets of the elk during both the pre- and the post-treatment periods. Sagebrush received little use at this time of the year. Ward concluded, "It appears that sagebrush control, if confined to limited and scattered areas, had no detrimental impact on elk during the calving period." (For more details, see Research Note RM-240, "Sagebrush Control with Herbicide has

Males grow new antlers in the spring. Herds summer in the high country and migrate to the lowlands in winter.

Cows generally calve between May 15 and June 15. Newborn calves are light brown with cream-colored spots. This cow is shedding her winter coat.

Little Effect on Elk Calving Behavior.")

To get some idea of the reaction of elk to cattle grazing, to recreational activities, and to motor vehicles, Ward turned to electronics experts at the University of Wyoming. Together, they decided to use radio transmitters and binoculars or spotting scopes to follow the movements of selected elk. The study site they chose was Pole Mountain on the Medicine Bow National Forest, an area of 88 sections on which there are approximately 150 elk. Interstate Highway 80, which cuts across the south edge of the area, carried an average of 8,600 vehicles per day during July and August of 1971. Over 300,000 visitations to recreation sites were recorded during the same period. Some 2,088 beef cows with calves grazed in the unit.

With the aid of a tranquilizer gun, Ward's crew placed collars containing small radio transmitters on two cow elk and made 89 tracking observations during the summer. Most data were collected during the mornings and evenings, when the elk were feeding. Highway noise was also recorded on 10 known feeding sites near Interstate 80.

The scientists were able to observe elk behavior in relation to grazing cattle, to recreational activities, and to highway traffic. Their observations suggest that elk are quite adaptable. Throughout the summer, elk were seen grazing with cattle. The 4-strand, barbed wire fences did not appear to limit their movement. However, the elk did stay away from people. A buffer of at least one-half mile was maintained by the elk whenever fishermen, campers, picnickers, or other people were in the vicinity. As long as the people remained in their cars, the elk seemed to have little fear. The elk were observed grazing within 300 yards of heavy traffic on Interstate 80, where noise levels reached 58 decibels.

Collar transmitters weigh about 2¼ pounds. Researchers using ground receivers can locate collared cows within a range of 1 to 6 miles. From an airplane, tracking range is about 10 miles.

About 7,500 elk winter at the National Elk Refuge in Jackson, Wyoming. The 24,000-acre Refuge was established in 1912.

Currently, research is under way in the Medicine Bow Range west of Laramie to evaluate the response of elk and of other big game to weather modification and to various types of road systems. Ward and his crew are gathering information that will help them identify, describe, and where possible, measure the factors which influence the movement, distribution, and general welfare of elk. The study area now supports a population of more than 700 elk.

Once again, radio-outfitted elk are being monitored to determine their use of the habitat. The new studies involve both aerial and ground tracking. Aerial tracking is proving most effective during those times of year when the elk are dispersed. Transmitter collars were placed on seven cow elk trapped in March of 1972 to begin this study. Additional collars were being placed on elk and other big game animals at the time this article was being prepared.

The scientists are also recording elk response to environmental factors other than snow and roads. Because logging is common in the study area, elk use of clearcuts is being observed, as are reactions of the elk to active timber harvesting.

Time-lapse photography is also playing a role in this study. Super 8-mm. movie cameras and 35-mm. time-lapse cameras are situated to monitor elk and livestock use of specific winter and summer feeding sites. The photos which have been collected are proving effective in quantifying use intensity as well as recording when use occurs.

There is much to be learned about elk reactions to various resource uses as well as elk habitat needs. Data from the team's studies should provide land managers with important information that will assist them in making management decisions that affect Rocky Mountain elk and their environment. □

The carrying capacity of winter ranges is a major factor in the dynamics of Rocky Mountain elk populations.

Richard H. Smith, Berkeley

Limonene

There's nothing very unusual about a ponderosa pine which has a little of the colorless, lime-scented chemical known as limonene in its xylem resin. But there is something unusual about a ponderosa that has a lot of limonene in it. Such trees are very rare, and they are worth finding and worth studying.

These are the opinions of Richard H. Smith, an entomologist with the U.S. Forest Service's Pacific Southwest Forest and Range Experiment Station in Berkeley, California.

Back in 1965 and 1966, Smith did some lab and field tests which suggested that ponderosa pines with more than the average amount of limonene in them may be relatively resistant to western pine beetle attacks. And that's an important quality to have, because the western pine beetle, if its population is at its peak, can leave timber growers in the western U.S. with a 700 to 800 million board foot loss in one year. Even when the beetle's population is not in epidemic or outbreak proportions, the beetles can still put the bite on a forester's profit-loss statement.

The xylem resin of which limonene is a part can be divided into two groups of components. The rosin portion of xylem resin makes up about 71 to 81 percent of the total resin. The terpene portion completes the remaining 19 to 29 percent. Ponderosa pines may have as many as ten different terpenes. Limonene and four other chemicals, a-pinene, b-pinene, 3-carene, and myrcene, are usually regarded as the major terpenes; the five other terpenes are minor and are usually found in lesser or trace amounts.

---- is it important?

Smith, who has studied more than 5,000 xylem resin samples which he collected from every major ponderosa pine region in the western U.S., says it's hard to generalize about the species' xylem resin composition. But, he explains that in an "average" ponderosa pine, the terpene content would be something like this: a-pinene, 6 percent; b-pinene, 21 percent; 3-carene, 51 percent; myrcene, 10 percent; and limonene, 9 percent. The high limonene ponderosas have a different formula. Theirs is: a-pinene, 20 percent; b-pinene, 0 percent; 3-carene, 0 percent; myrcene, 20 percent, and limonene, 60 percent.

So far, Smith has found eight ponderosas that could be termed high limonene trees. Their special terpene composition gives them something in common with five other pines. These are: Hartweg pine *(Pinus hartwegii)*, a Mexican pine which grows at higher elevations than any other pine in the world; Italian stone pine *(P. pinea),* which is very common in the Mediterranean countries; Pince's pine *(P. pinceana),* a very rare tree found in a few desert ranges of Mexico; pond pine *(P. serotina),* which occurs in little clusters around certain ponds in the southern United States; and Torrey pine *(P. torreyana),* which occurs near San Diego and on Santa Rosa Island in California.

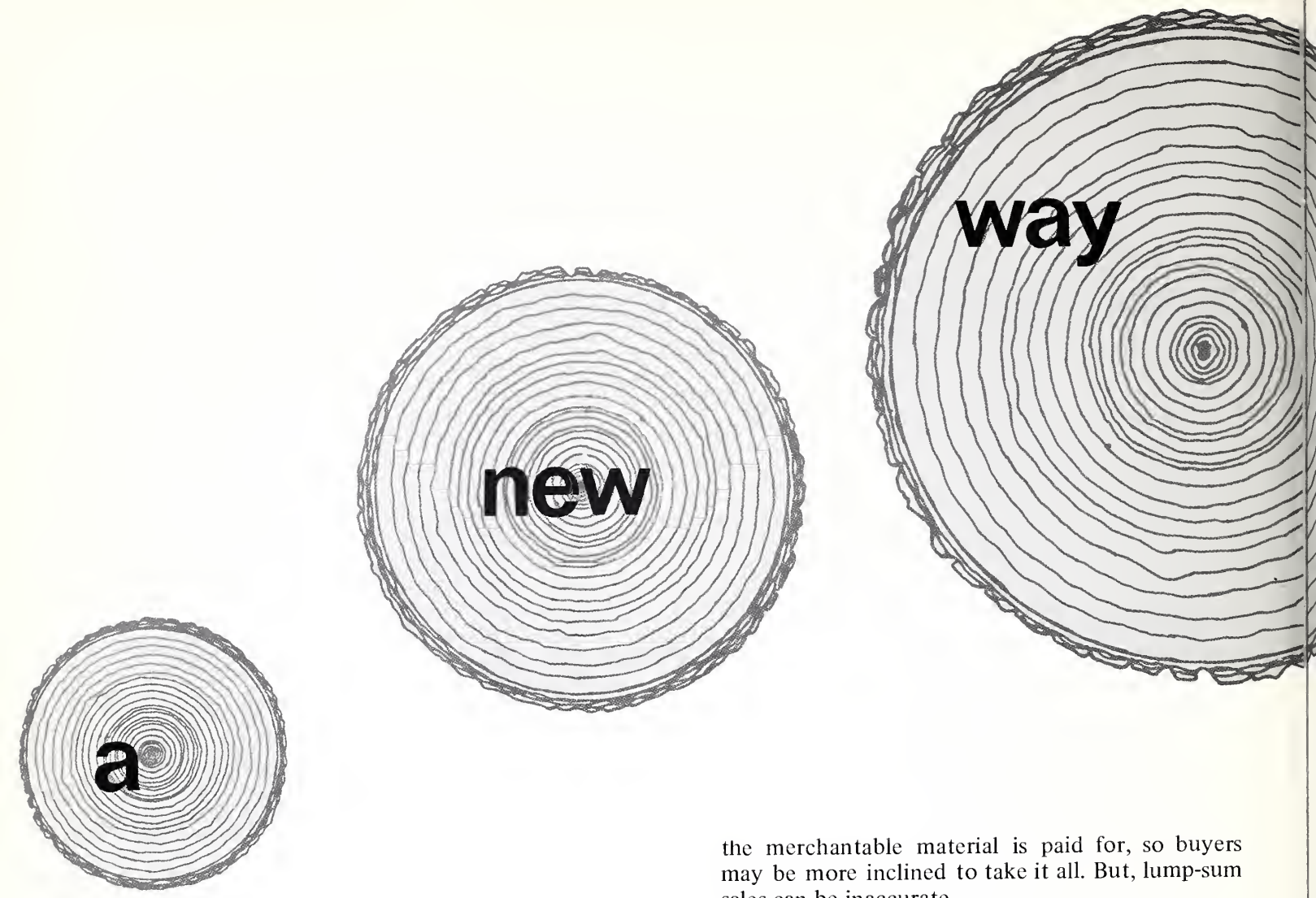
Smith says that high limonene content is the rule rather than the exception in these species. He plans to study them in hopes of learning something that will help him with his ponderosa research. This comparative study may take some doing because the high limonene pines, with the exception of Italian stone pine, aren't widespread. Furthermore, not much work has been done on them.

If the high limonene research goes well, the unusual ponderosas may someday be selected for forest planting. But there's a lot more work to be done before that day arrives.

Smith wants to continue tests of resistance to western pine beetle attacks. Here are some of his earlier findings:

- In a 1965 lab test, limonene was more toxic to adult western pine beetles than the four other major terpenes that occur in ponderosa pine resin;
- In a 1966 study, Smith found that, of all the ponderosas included in the study, those trees with the highest percentage of limonene in their xylem resin were the least frequently attacked and killed by bark beetles.

Smith also has a breeding program lined up for the high limonene ponderosas. The breeding study has two origins. The first is necessity—it's pretty hard to do a study when you've only got eight subjects on which to work. The second origin is curiosity. Smith wants to know if high limonene content is a genetically controlled trait. He has already made one set of controlled crosses of high limonene trees, but more elaborate crosses will have to wait until the appropriate female trees produce cones. To a scientist who is used to doing much of his work with equipment that can analyze hundreds of xylem resin samples in a single month, a year may seem like an interminably long time to wait for a good cone crop. "It's enough to make you want to run out to the tree and do a fertility dance," Smith said. □



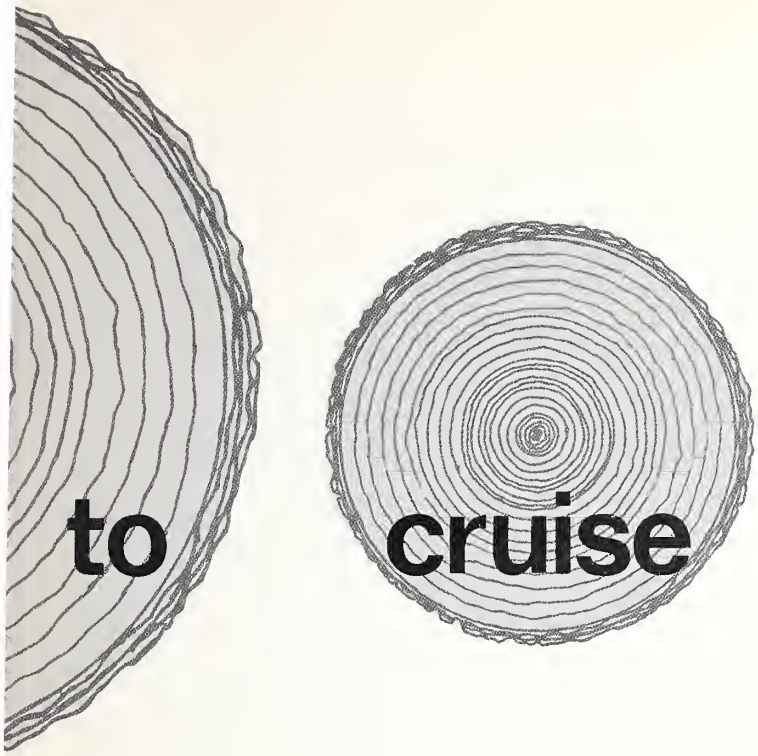
Over the years, there's been a lot of discussion about which is the best method of selling timber – by lump-sum sales or scale sales. Both methods involve cruising, the measuring and grading of trees to determine the volume and the value of the timber in a sale area. In a lump-sum sale, the timber is cruised, a price tag is put on the whole stand, and the timber is sold "lump sum." In a scale sale, cruising is done and a per-thousand-board-foot price is established and applied to the logs that are taken from the woods. Scale sales require special measuring or "scaling" stations.

Both kinds of sales apparently have advantages and disadvantages. For example, scale sales are costly and may encourage operators to leave a lot of residue in the woods because buyers only pay for what they take out. On lump-sum sales, all the merchantable material is paid for, so buyers may be more inclined to take it all. But, lump-sum sales can be inaccurate.

Now a new technique called "fall, buck, and scale (FBS) cruising" offers another option. With it, timber growers can sell lump sum, without having to measure every tree in the sale area. And, the accuracy of FBS cruising is such that scaling is not required after logging.

There are many other advantages of FBS cruising over older methods. In a traditional cruise, the cruiser uses biltmore sticks, optical measuring devices, and "guestimate" to estimate the volume and value of standing trees. FBS cruising, in contrast, employs a totally new concept. Instead of measuring trees as they stand, sample trees are felled, bucked into standard log lengths, and measured on the ground. The cruiser can measure the diameter and length of the logs as they are cut, and can accurately determine defect, breakage, taper, and other factors which are hard to evaluate on standing trees.

FBS cruising was developed by the Bureau of Land Management in cooperation with researchers at the Pacific Northwest Forest and Range Experi-



ment Station in Portland, Oregon. The original idea for the method can be traced to Leonard Zygar, a cruiser with the BLM's Salem District in Oregon. At a training session several years ago, Zygar asked, "Why not cut the sample trees?"

The solution seems so simple that a lot of people wonder why no one thought of it before. One reason is that, until recently, the available sampling systems required so many sample trees for acceptable accuracy that the idea of cutting them all down was unthinkable. Now, with a statistical sampling method called 3-P, a few sample trees are entirely adequate. For any given sale in which FBS cruising is used, anywhere from 50 to 200 sample trees are selected by 3-P sampling. The 3-P system was developed by Lew Grosenbaugh at the Forest Service's Pacific Southwest Forest and Range Experiment Station about 10 years ago; under the system, the *probability* that a tree will be included in the sample is *proportional* to a quickly *predicted* ocular volume. Thus, 3-P.

The BLM adopted the 3-P technique as soon as it became available in 1964. At first they measured the sample trees standing. It wasn't until 1968 that they started falling them. George Hartman, a forester with the BLM in Portland, says they saw FBS cruising as a way to get highly accurate estimates without having to measure all the trees in a sale.

The BLM first tried FBS cruising to solve a no-bid situation on a sale near Roseburg, Oregon, in 1968. The timber was advertised but didn't sell, apparently because nobody thought the volume was there. So, the BLM did a fall, buck, and scale cruise, came up with an estimate that the purchasers believed, and sold the timber.

Hartman says about 25 percent of the volume in the BLM's timber sale program for fiscal year 1974 will be cruised by this technique. That amounts to about 295 million board feet in Oregon and Washington.

Prior to February of this year, the BLM had used FBS cruising on about 100 sales. Hartman is enthusiastic and believes the BLM should eventually work toward cruising about 90 percent of all sales by this method.

"The big benefit of FBS cruising is improved accuracy," according to Floyd Johnson, statistician for the Pacific Northwest Experiment Station. Johnson, who has been working with the Bureau of Land Management and the Forest Service to help get the system tested and put into use, finds FBS cruising intriguing. He says that FBS cruising is "a very practical idea," and that when accuracy is a major consideration, "FBS cruising has a lot of potential for doing the job better and cheaper than other cruising methods."

Johnson says that FBS cruising makes a lot of sense, particularly in defective old-growth timber in the West where there is a good chance of making a bad estimate. According to Johnson, FBS cruising gets rid of the cruiser's bias, so that only sampling error is left.

Johnson believes FBS cruising might also be especially useful for selective cutting in the pine region. With 3-P sampling, at least at present, the

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publications

▶ Did you know that hunting accidents are usually caused by males with 3 or more years of hunting experience? That one insurance company rates hunting 16th on the list of dangerous sports? That remote control photography is the quickest and easiest technique for quality night photography of animals? That the hunting fraternity in Poland is an elite social group?

These facts and more are included in General Technical Report PNW-4, "Human Behavior Aspects of Fish and Wildlife Conservation – An Annotated Bibliography," by Dale R. Potter, Kathryn M. Sharpe, and John C. Hendee of the Pacific Northwest Station. The 288-page, soft-bound book lists some 995 publications. The report not only has the usual essentials such as author, date, title, and publisher for each entry, but also contains an author index, a keyword index, and a short, informative summary of each article listed. The publication is designed for students, teachers, conservationists, wildland managers, and researchers working in the area of people-wildlife management problems.

▶ All the good things that can be said about the sturdy little shrub called creeping sage (*Salvia sonomensis* Greene) have probably been said by Clinton B. Phillips, Louis E. Gunter, Grant E. McClellan, and Eamor C. Nord in a report that is part of the California Division of Forestry's series of Fire Control Notes. In "Creeping Sage – a Slow Burning Plant Useful for Fire Hazard Reduction," the four authors say that this plant is a leading candidate among the species now being tested for low flammability. The report is available from the Pacific Southwest Station.

A California native, creeping sage is low in fuel volume. Under proper conditions, it makes rapid growth from rooted transplants or from fresh stem cuttings, and it also does well when planted by direct seeding.

And that's just for openers. The authors say that the plant's leafy, mat-like base expands every year and can thus drive out the neighboring and more flammable annual plants. The shrub has a lot of little niceities about it, too – it's aromatic, it puts out bright blue flowers in spring, and it is a good source of honey nectar.

The plant is a winner when it comes to tests of low flammability, and this is the attribute that the writers emphasize. They found that, on the average, fire spread nearly five times more rapidly in annual grasses and forbs than in creeping sage, and that the rate of heat energy output was less in creeping sage than in annuals at the sites tested.

The list of creeping sage's shortcomings doesn't seem formidable enough to make one's interest in the plant wither. The authors say that, after a burn, creeping sage doesn't resprout from either the roots or the stems. Also, it's susceptible to weed killers.

▶ In the past 10 years, more than 100 million gallons of fire-retardant chemicals have been dropped on forest and rangeland fires by fire control agencies throughout the United States. How well these chemicals do their job depends on their formulation, drop characteristics, and ground-distribution patterns.

A new report by the Intermountain Station presents the results of drop tests made with the three most commonly used retardant formulations to determine the effect that thickening agents, wind speed and direction, drop height, and aircraft speed would have on ground-distribution patterns.

The report, "An Evaluation of the Drop Characteristics and Ground Distribution Patterns of Forest Fire Retardants," Research Paper INT-134, by Charles W. George and Aylmer D. Blakely, contains data that should lead to the development of more effective retardants and to safer guidelines for aircraft use.

For example, the statistical data and mathematical models can be used to predict the best height at which a drop should be made to fit a given set of fire conditions. Optimum aircraft altitude for various wind speeds and directions can be determined from prediction tables. The data can also be used by fire specialists to determine when a gum-thickened retardant will permit safer drop heights with maximum effectiveness or when the salt content or solution volume of a retardant should be modified.

The 60-page report contains 26 pages of data and algebraic models for the determination of the ground-pattern responses of each of the three retardants tested.

Two earlier reports related to fire research are also available from the Intermountain Station. They are: "Effects of Ammonium Sulfate and Ammonium Phosphate on Flammability," Research Paper INT-121, by Charles W. George and Aylmer D. Blakely, and "The Effects of Two Flame Retardants on Particulate and Residue Production," Research Paper INT-117, by C. W. Philpot, C. W. George, A. D. Blakely, G. M. Johnson, and W. H. Wallace, Jr.

The devastating flood that swept through Rapid City, South Dakota, on June 9 and 10, 1972, can't be blamed on abusive land management practices. This is one of the observations made by Howard K. Orr in "The Black Hills (South Dakota) Flood of June 1972: Impacts and Implications" (Forest Service General Technical Report RM-2). Orr, who is a research forester at the Rocky Mountain Station's laboratory in Rapid City, reconstructed the events leading to the flood, and analyzed the effects torrential rainfall had on Black Hills watersheds.

Orr looked at weather records to determine the probability that conditions similar to those that led to the heavy June 9 rainfall would ever again develop. He came up with recurrence estimates that varied from four times the amount expected once in 100 years on the average, to once in several thousand years.

Orr discovered that watersheds contributing to the flood were in *good* hydrologic condition. Damage to watersheds was minimal considering the intensity of rainfall (some areas received as much as 12 inches of rain during a 6-hour period). The most damage occurred in major stream channels, especially where debris from man-made structures accumulated during the flood.

There's no clear answer to the question of how effective mechanical thinning is as a method of treating overstocked stands of young conifers. What is known for sure is that overstocking of such stands is all too common in the western United States. In overstocked forests it is often hard to find a tree that will produce any timber product other than a corral pole. Wildlife loses out, too, because there often isn't much accessible forage in a typical overstocked area.

In "Mechanical Thinning of Young Conifer Stands," a reprint available from the Pacific Southwest Station, author Donald W. Lynch says that stocking of 5,000 to 10,000 stems per acre is common in many forests of the Western states, particularly in lodgepole pine. More dramatic examples of overstocking are those stands in which 20,000 trees per acre are in severe competition; such trees may never grow to commercial size.

A strong proponent of mechanical thinning is Samuel S. Evans, formerly chief silviculturist for the Forest Service's Northern Region. The Region is a leader in mechanical thinning; crews there thin from 2,000 to 4,000 acres every year. Evans told Lynch that mechanical thinning is crude and inexact, but that it is "a necessary step in rehabilitating many areas that otherwise will never produce commercial timber products."

Mechanical thinning doesn't look as good in some other Forest Service studies. Lynch writes that on the Medicine Bow National Forest, both a roller-chopper, which was drawn behind a tractor, and a roller mounted on a bulldozer blade, were used in thinning. But, the large amounts of material left in the strips after treatment created a high fire hazard. Also, according to Lynch, the treated areas were unsightly.

In Lynch's opinion, hand thinning – using hand tools or power saws – is an all but impossible physical job and isn't much of an alternative to mechanical thinning. He says that researchers generally concede that mechanical thinning equipment now available needs to be evaluated and that the stand criteria and characteristics that justify mechanical thinning need to be determined.

Questions are often asked about the effects of timber management on other resource values, such as wildlife habitat. Olof C. Wallmo, research wildlife biologist for the Rocky Mountain Station in Fort Collins, Colorado, examined the influence of clearcutting on deer food availability in the Rocky Mountains. His co-researchers were Wayne L. Regelin and Donald W. Reichert, also of the Rocky Mountain Station.

The study area was established on the Fraser Experimental Forest, where strips of lodgepole pine and spruce-fir had been clearcut for watershed experiments some 15 years earlier. The cleared strips varied from 1 to 6 chains in width and were each about 600 feet long. Corresponding strips of

publications

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timber had been left uncut. The study site extended from 9,500 to 11,000 feet in elevation.

The test subjects in this experiment were "tame" deer – animals that had been trapped as fawns and raised at the Experimental Forest. Because the deer were accustomed to people, the researchers were able to observe them from a short distance. The scientists noted what the deer ate on summer range, and where they preferred to feed. (An earlier study which Wallmo co-authored showed that forage choices of tame deer are similar to those of wild deer.)

The grazing trials were conducted during the summers of 1969 and 1970. Each grazing trial was started at a randomly selected point from which the deer were permitted to move freely into either the forested or the cutover areas.

The study revealed that the deer obtained 63.3 percent of their forage from the clearcut strips, 27.4 percent from the uncut strips, and 9.3 percent from logging roads. The researchers also found that 13 plant species comprised 92 percent of the deer diets. There were more pounds per acre of these plants on the clearcut areas than on the forested tracts. In addition, measurement of random plots on clearcuts showed that these plots had a greater variety and a greater abundance of the species sought by the deer than did the forested plots.

Additional results of the study are in "Forage Use by Mule Deer Relative to Logging in Colorado," a *Journal of Wildlife Management* (October 1972) reprint that may be requested from the Rocky Mountain Station.

▶ Can fire be used as an effective management tool on semidesert grass-shrub rangelands in the Southwest? Will fire kill shrubs that crowd out valuable forest grasses? Can grass production be improved by periodic burning?

Dwight R. Cable, range scientist at the Rocky Mountain Forest and Range Experiment Station field laboratory in Tucson, Arizona, has summarized years of research on this subject in "Fire Effects in Southwestern Semidesert Grass-Shrub Communities." This paper is part of the proceedings of the 1972 Tall Timbers Fire Ecology Conference.

Cable assembled observations dating back to 1910 and research findings dating back to 1937. He found that shrubs like burroweed, larchleaf goldenweed, cacti, young velvet mesquite, and young creosotebush can be killed by fire in June, the hottest month in the Southwest, if enough dried grass and other fine fuels are available to carry a fire hot enough to do the job. Where dense stands of mature shrubs, such as velvet mesquite and creosotebush, exist there is seldom enough fine fuel to carry a fire that is sufficiently hot to kill the shrubs. Some species, when mature, are protected by thick bark and/or possess tremendous sprouting ability. Both of these characteristics are mechanisms which negate the effects of fire.

Cable found that fire reduces the productivity of some perennial grasses, while increasing that of others. He concluded that the advantages and the disadvantages of burning perennial grass stands are such that they cancel each other out. Fire appears to be effective as a tool for controlling only selected shrub species, thus reducing their competition with desired grasses.

▶ Foresters interested in the economics of thinning ponderosa pine in the West may find help in a recent report from the Pacific Northwest Station. Although it is based on a study of thinning in the pine-grass areas of central Washington, the economic aspects of the research can be applied to other parts of the ponderosa pine region.

Researchers tested stocking levels of 62, 125, and 250 trees per acre to determine if thinning would increase the productivity of stagnated sapling stands. In this study, stands thinned to 125 trees per acre generally produced greater economic returns than the stands thinned to the other levels tested.

The study is described in Research Paper PNW-144, "Economics of Thinning Stagnated Ponderosa Pine Sapling Stands in the Pine-Grass Areas of Central Washington," by Robert W. Sassaman, James W. Barrett, and Justin G. Smith. It is a "first step" in developing thinning guides for ponderosa pine, and it applies primarily to stagnated sapling stands. Researchers point out that the 125-tree

figure might not be the ultimate one, and that some level tested in a future study may prove to be even better.

The researchers also learned that the economic returns from precommercial thinning were greater when the "allowable cut effect" was included. This refers to an immediate increase in allowable cut based on expected future increases in timber yields. When the allowable cut effect is used, the expected gain is spread equally over the years remaining until final harvesting, instead of waiting 50 years or so to absorb all of the increase in one year.

Researchers looked at the economics of both clearcutting and shelterwood cuts and found that returns were greater from clearcutting. But, the best shelterwood system ranked a close second to the best clearcut system.

The authors also looked at forage production, a factor that is not important in all parts of the ponderosa pine region, but is important in central Washington. Economic returns were, of course, greater when these timber lands also produced forage crops. But how much greater? And were they enough to justify the additional cost of planting forage crops? The decision hinges on a marginal analysis of the costs and the returns associated with the planting and utilization of forage. Sassaman discusses this topic in "Economic Returns from Planting Forage in National Forests," an article from the August 1972 *Journal of Forestry*. Reprints are available from the PNW Station.

▶ The Intermountain Forest and Range Experiment Station has recently published two annotated bibliographies that cite a treasury of information on watershed and recreation research.

One spans almost a half-century of research conducted on the Davis County Experimental Watershed in Utah's Wasatch National Forest – research which has influenced watershed management throughout the world. The bibliography includes 88 citations; the earliest published in 1925, the latest in 1973.

A chronological review of the citations shows that changes in land use and in public attitudes led to the rehabilitation and protection of these valuable watersheds. Early citations describe the devastating floods and mud-rock flows that hit the denuded watersheds in 1923 and again in 1930. Rehabilitation techniques and control of overland flow and erosion are stressed in the material published in the mid-1930's through the 1950's. The tone of the more recent publications shows an increasing emphasis on research for water yield improvement.

Copies of the bibliography are available from the Intermountain Station. Write for "Research Related to the Davis County Experimental Watershed: An Annotated Bibliography," General Technical Report INT-4, by Norbert V. DeByle and Ezra Hookano, Jr.

Recreational carrying capacity – the level and type of recreational use that a natural or developed area can sustain before either the resource or the "recreational experience" begins to deteriorate – is a major management and research concern. The second bibliography contains more than 200 citations covering both the ecological and social impacts of recreational use.

Although there are no "cookbook" formulas for deciding whether recreational use should be controlled, the articles listed contain practical data that will help managers and administrators make decisions that will prevent unacceptable losses to either the resource complex or the recreationist's experience.

Copies of "Recreational Carrying Capacity: An Annotated Bibliography" (General Technical Report INT-3), by George H. Stankey and David W. Lime, are available from the Intermountain Station.

▶ What makes some Douglas-fir trees more prone than others to being browsed by deer? The answer, according to forest scientists in Olympia, Washington, probably has something to do with the tree's chemistry.

In laboratory tests, M. A. Radwan, a plant physiologist with the PNW Station in Olympia, Washington, took a close look at the chemistry of four different clones of Douglas-fir and tested their digestibility as deer browse. The clone most susceptible to deer browsing proved to be highly digestible and to have needles lower in total fat, phenol, flavanol, and leucoanthocyanin content. One clone, not heavily browsed, rated low in digestibility and low in chlorogenic acid, a compound not previously identified in Douglas-fir.

It looks as though deer really know what

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continued

they're doing when they browse because they obviously tend to select the more digestible trees. Scientists aren't ready yet to say conclusively just what caused the preferences. But there is enough evidence to assume that deer browsing habits are related to genetic differences in the trees, and that there is merit in trying to breed Douglas-fir for resistance to deer browsing. Chlorogenic acid may be the key ingredient.

It's all spelled out in "Differences Between Douglas-fir Genotypes in Relation to Browsing Preference by Black-tailed Deer," an article by Dr. Radwan from the September 1972 *Canadian Journal of Forest Research.*

▶ A statistical technique that's "as old as the hills" may be used to measure the grass that's growing on them. The method is two-stage stratified sampling, which was developed in the 1930's and is well known to most statisticians. Two California researchers, Gene Conrad and Bill O'Regan, both of the Pacific Southwest Forest and Range Experiment Station in Berkeley, say this old method can be used in a new way—to get improved estimates of herbage yield.

In Research Note PSW-278, "Two-Stage Stratified Sampling to Estimate Herbage Yield," Conrad and O'Regan describe the two-stage process and explain the equations needed to arrive at the estimated mean weight per element in the population for the given species and the estimated variance of that mean. They also include equations needed to calculate the number of plots that should be measured and to calculate the sample size, a factor that is particularly important to range scientists whose budget limits the amount of time they have to do any sampling.

Conrad and O'Regan say the method should work for estimating the yield of any annual vegetation that is similar to that growing on the San Joaquin Experimental Range, the central California grassland where they tested the technique. They compared two-stage stratified sampling with one of the most widely used techniques, simple random sampling, and found that the minimum variance using two-stage stratified sampling was 15 percent less than that obtained from using simple random sampling.

▶ Careful use of a new snowmelt model should enable resource managers to better predict how a given management alternative will affect the timing and the amount of snowmelt. The computer model, which simulates snowmelt in the Rocky Mountains, was organized by research hydrologist Charles F. Leaf and computer programer Glen E. Brink, both of the Rocky Mountain Station at Fort Collins, Colorado. Their model is based on a program developed at the Pacific Southwest Station.

The program is designed to simulate: (1) winter snow accumulation; (2) energy transfers resulting in melting or freezing conditions; (3) snowpack state (winter or spring); and (4) the resultant snowmelt under a variety of environmental conditions . With this model, the scientists have predicted probable snowmelt changes resulting from forest cover manipulation and from additions to the winter snowpack through weather modification.

A description of the model is in Forest Service Research Paper RM-99, "Computer Simulation of Snowmelt Within a Colorado Subalpine Watershed."

fbs cruising

continued

forester must visit every tree in the sale area and make a rough, "eyeball" estimate of volume. Only a few trees are actually measured. Because the forester must mark all trees to be cut in a selective harvest anyway, there's very little extra work involved in measuring the sample trees.

So far, FBS cruising has caught on mainly with the BLM in the Douglas-fir region, but Johnson feels it may be just as useful to other organizations and in other regions. The U.S. Forest Service is currently studying the method for possible use in the National Forests of Oregon and Washington. Current Forest Service policy is to shift from log scaling to payments based on cruised volumes of timber. If FBS cruising is as accurate as its proponents believe, it may be used in implementing the new policy. □

a note to you

This is the first edition of FORESTRY RESEARCH: What's New in the West. We hope, in this and in future issues, to let you know about the work being done at the U.S. Forest Service's Intermountain, Pacific Northwest, Pacific Southwest, and Rocky Mountain Experiment Stations.

Your comments and suggestions are always welcome. Send them to: FORESTRY RESEARCH: What's New in the West, U.S. Forest Service, Post Office Box 245, Berkeley, California 94701.

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